Steps to Sustainability
Part 33 of a Series:
Systems Thinking:
The Historical Background

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Our previous Steps to Sustainability piece of November 21 – 27, 2016, Vol. 11, No. 39, pages 6 and 11 focused on "tipping points." A tipping point can be thought of as something that happens within or to a system. Among sustainability advocates and activists, "systems thinking" has become the norm. In her widely used introductory book on *Thinking in Systems: A Primer*, Donella H. Meadows (2008:11) defines a system as "an interconnected set of elements that is coherently organized in a way that achieves something." Beyond this basic definition, systems have numerous properties that merit the attention of all who are interested in sustainability. Meadows was one of the primary authors of the famous 1972 MIT study on *Limits to Growth* that we summarized in a Steps to Sustainability essay in *Tompkins Weekly* Volume 7, Number 23 of June 3, 2013.

The *Limits to Growth* study was one of the earliest uses of computer simulations but systems thinking had already begun to spread widely by 1972. Indeed, systems thinking began to develop near the beginning of the 20th Century. How this happened is the subject of a brief historical review in physicist Fritjof Capra's book, *The Web of Life: A New Scientific Understanding of Living Systems*. Capra notes that systems thinking developed from attempts to solve problems that developed in 19th and 20th century science. Earlier in the16th and 17th centuries, great scientific thinkers such as Copernicus, Galileo, and Descartes overthrew

the mystical church-sponsored version of nature. Their revolutionary new thinking was influenced by inventions such as the telescope and various mechanical devices. Descartes published his famous *Discourse on the Method* in 1637. He proposed to analyze complex phenomena by breaking them into small pieces. He argued that we understand the whole by understanding the properties of its parts (Capra 1996:19). This approach was perfected almost a century later by Sir Isaac Newton whose work seemed to prove the world to be "a perfect machine governed by exact mathematical laws" (Capra 1996:20). One implication of the scientific worldview of those times was that ultimately all fields of science would be reduced to physics. This is one example of the concept of *reductionism* that is today anathema to systems thinking.

By the beginning of the 20th Century Cartesian analysis had been established as the main paradigm in Western science for nearly 400 years. But gradually over this span of time various critics had raised questions about its ultimate usefulness. It was noted, for example, that "the taste of sugar is not present in the carbon, hydrogen and oxygen atoms that constitute its components" (Capra 1996:28). It was also asked how the laws of physics and chemistry could fully explain life. Is there life in the smallest particles of the bodies of living creatures in the smallest particles that together generate it? True, the great 19th Century French scientist Louis Pasteur had seemingly reduced the spread of certain diseases to a "particle" in the body: the germ. But as cell biology developed in the 20th Century, researchers made an unexpected discovery that complicated matters: in higher organisms, as the cells increase in number through doubling, strangely, the genetic information that is identical in each cell nonetheless results in a dizzying array of different and specialized outcomes – muscle, blood, bone, nerve and so on (Capra 1996:25).

Finally, the mechanistic scientific paradigm of Descartes and Newton fell victim in physics itself to the theory of relativity and to quantum physics. In relativity Einstein's particles change size as they approach the speed of light – an apparent fact that would not easily fit into Descartes' paradigm. And in his 1987 book, *Beyond Einstein: The Cosmic Quest for the Theory of the Universe*, theoretical physicist Dr. Michio Kaku (1987:119) notes that by the 1950s, quantum "physicists were drowning in an ocean of subatomic particles." And yet we can ask: are there sub-sub particles beneath those? If so, how many and how many layers? The search for a

set of basic parts of the universe that would explain the whole became more and more elusive.

The dissolution of the Cartesian-Newtonian scientific paradigm ran parallel to a burgeoning set of new approaches in biology that became the essential components of the systems thinking that sustainability thinkers and activists utilize and depend on. In our next installment, we shall summarize a few of these and then begin our overview of some fundamental principles and concepts of systems thinking.

738 words

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